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Lactational Performance of Holstein Dairy Cows Fed Two Levels of Full-fat Corn Dried Distillers Grains with Solubles

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Summary and Implications

The lactational performance of 30 healthy multiparous Holstein dairy cows was tested when cows were fed 0, 10, and 20% dried distillers grains with solubles (DDGS) that contained 13.6% fat on a dry matter (DM) basis. Cows fed 10% DDGS on a DM basis experienced a reduction in milk fat percentage of 0.5 percentage points, but did not perform differently in other measures than did cows not fed DDGS. When cows were fed 20% DDGS on a DM basis, every common measure of feed utilization was impacted negatively.

Introduction

An important consideration when choosing any feed ingredient to include in a ration is the influence that the feed ingredient has on the productivity of the food-producing animal. Recently, increased ethanol production from corn in the Midwest has resulted in the increased availability of distillers grains and co-products. Moreover, dried distillers grains with solubles are often an economical protein source for animal production. Dried distillers grains with solubles (DDGS) are also a good source of rumen undegradable protein (RUP) in the ration of a lactating dairy cow. Prior research has indicated that DDGS can effectively be fed to lactating dairy cows without changing DMI or milk fat percentage while either not affecting or, in some cases, increasing yield of milk, energy corrected milk (ECM) yield, fat, protein and feed efficiency when compared with a traditional total mixed ration (TMR). Conversely, our prior research showed decreased milk fat percentage and milk yield when cows were fed 25% DDGS with 12.1% fat. Additionally, composition and nutritional value of DDGS can be highly variable, depending on manufacturing practices even within the same ethanol plant. As the ethanol industry has matured, however, so has the realized value of DDGS as a co-product rather than as a by-product. Consequently, ethanol production plants have developed more consistency in the nutritional quality of DDGS they produce. Therefore, it was the objective of this study to investigate the effects of feeding full-fat DDGS produced with current manufacturing practices on the feed efficiency and production performance of lactating Holstein dairy cows. In addition, based upon our prior research, we hypothesized that feeding full-fat DDGS at 20% of dietary DM to lactating dairy cattle would negatively influence the production and efficiency of dairy cows when compared with a traditional TMR.

Materials and Methods

Thirty cows were fed 0, 10, and 20% full-fat DDGS dry matter (DM) as a total mixed ration (TMR) in a 3 × 3 Latin square with repeated measures. Cows were stratified into groups of 10 by parity and days in milk and fed each of three isonitrogenous and isoenergetic diets in three 28-day periods (Tables 1 and 2). Cows were allowed ad libitum access to feed and water and individual daily feed intake was measured by using Calan gates (American Calan Inc, Northwood, NH). Feed was delivered to allow for approximately 15% reclaim. Because there was no washout period between treatments, the first 13 days of each experimental period were excluded from data analyses. Statistical analyses of milk composition, yield, and feed efficiency were performed by using SAS version 9.3 (Cary, NC) and Proc MIXED. Data were analyzed as repeated measures, with the repeated statement sample date with the subject being cow nested within treatment × period. The model included two fixed effects (treatment and parity), group as a random effect, and days in milk as a covariate. Means were separated by using Tukey's multiple comparisons tests. Crude protein and net energy for lactation of feed were analyzed by using the Student's t-test.

Results and Discussion

The effect of DDGS on DMI was inconsistent, with the control diet being intermediate to the 10 and 20% diets (Table 3). Milk yield was unaffected by feeding DDGS; however, feeding DDGS did cause milk fat depression and decreased daily fat yield, resulting in significant decreases in 3.5% fat-corrected milk (FCM) yield and energy-corrected milk (ECM) yield (Table 3). Both protein and lactose percentages increased significantly when cows were fed 20% DDGS; neither protein nor lactose yield, however, was affected (Table 3). Protein efficiency, a measure of the utilization of dietary protein for milk protein synthesis, decreased significantly for cows fed 20% DDGS, likely resulting from heat-damaged protein (Table 3)

All three measures of energetic efficiency (ECM/DMI, kg ECM/net energy for lactation (NEL) intake (mcal), and gross energy of milk produced (mcal)/NEL caloric intake (mcal)) were significantly decreased when cows were fed 20% DDGS, but not when cows were fed 10% DDGS (Table 3). These results indicate that, with the exception of an approximate loss of milk fat of 0.5%, full-fat DDGS used in this study can be effectively fed at 10% without a loss in production performance when compared with a traditional TMR. Feeding the full-fat DDGS at 20%, however, is not advisable.

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Table 1. Feed formulations of three treatment diets, fed as a total mixed ration, containing different concentrations of dried distillers grains with solubles (DDGS)

	Treatment		
Ingredient, % DM	0% DDGS	10% DDGS	20% DDGS
Corn silage	31.4	27.9	22.7
Alfalfa hay	19.5	19.5	19.5
Soybean meal (48%)	1.8	0.0	0.0
Soy Plus*	4.2	1.3	1.4
Cottonseed (whole)	8.6	8.6	8.6
Finely ground corn	28.1	26.3	23.0
DDGS	0.0	10.0	20.0
Supercharger II®†	0.9	0.9	-
Limestone	0.8	0.8	1.5
Blood meal	0.6	0.6	-
Sodium bicarbonate	0.6	0.6	0.6
Rock salt	0.5	0.5	0.5
Animal fat	-	-	0.4
Urea	0.4	0.4	-
Pork meat and bone meal	0.3	0.3	-
Monocalcium phosphate 21%	0.2	0.2	-
Magnesium oxide	0.2	0.2	0.2
Metasmart®‡	0.1	0.1	0.1
Dynamate®§	0.1	0.1	-
Dairy balancer II®¶	0.1	0.1	0.1
Monensin 90®	0.01	0.01	0.01
Forages	50.9	47.5	42.3
Concentrates	49.1	52.5	57.7

*West Central Cooperative, Ralston, IA.
†Fat supplement (Origo, New Ulm, MN)
‡Methionine supplement (Adisseo USA Incorporated, Anpharetta, GA)
§Vitamin and trace mineral premix (Consumer's Supply Distributing Company, Sioux City, IA)
¶Vitamin and trace mineral premix (Nutritional Professionals Incorporated, Hortonville, WI))

Table 2. Proximate analyses of dried distillers grains with solubles (DDGS) and pooled total mixed rations

		Total mixed rations*		
Component	DDGS	0%	10%	20%
Moisture, %	9.56	43.8	41.4	37.1
Dry matter (DM), %	90.44	56.2	58.7	62.9
Crude protein (CP), %	32.55	16.6	17.1	16.9
ADF, %†	17.1	20.4	23.7	21.8
aNDF w/Na_2SO_3, %‡	N/A	30.6	32.4	28.8
Lignin (sulfuric acid), %	4.4%	4.1	5.6	5.6
Lignin % of NDF, %	19.5	13.3	17.4	19.6
AD-ICP§ % of CP, %	19.0	10.9	14.0	18.9
AD-ICP % of DM, %	6.1	1.8	2.4	3.2
ND-ICP¶ % of CP est. w/o Na_2SO_3, %	N/A	16.0	16.0	16.0
ND-ICP % of DM est. w/o Na_2SO_3, %	N/A	2.7	2.8	2.8
Fat, %**	13.5	5.6	6.9	7.6
Ash, %	5.1	6.9	6.7	6.9
Calcium, %	0.1	1.0	0.9	1.0
Phosphorus, %	1.0	0.4	0.4	0.4
Magnesium, %	0.4	0.3	0.3	0.3
Potassium, %	1.1	1.2	1.2	1.1
Sulfur, %	0.9	0.2	0.3	0.4
Sodium, %	0.2	0.4	0.4	0.5
Chloride, %	0.2	0.6	0.6	0.6
T. D. N†† – OARDC‡‡,%	85.2	71.5	69.1	69.8
N. F. C. §§	26.3	41.0	37.8	40.7
N. E. L. ¶¶- OARDC, Mcal/kg	2.0	1.6	1.6	1.6
DCAD***, mEq/100 g	-5.3	3.9	2.8	1.8

*Data are expressed as the means of 6 pooled samples as a percentage of dry matter.
†Acid detergent fiber.
‡Amylase-treated neutral detergent fiber with sodium sulfite.
§Acid-detergent insoluble crude protein.
¶Neutral-detergent insoluble crude protein.
**Total mixed rations determined by ether extract and DDGS determined by petroleum ether extract.
††Total digestible nutrients.
‡‡A summative calculation based on an Ohio Agricultural Research and Development Center method (an approach for energy evaluation).
§§Non-fiber carbohydrate.
¶¶Net energy for lactation.
***Dietary cation anion difference (DCAD) = $(Na^+ + K^+) - (Cl^- + S^{2-})$.

Table 3. Effects of feeding dried distillers grains with solubles (DDGS) at 0, 10, and 20% dietary inclusion (DM) on dry matter intake (DMI), milk production and composition, and feed efficiency expressed as grand mean ± the standard error of the mean

	Treatment			
Item	0% DDGS	10% DDGS	20% DDGS	*P* - Value
DMI (kg/d)	25.22±1.18[b]	24.03±1.18[a]	26.37±1.18[c]	<0.0001
Milk yield (kg/d)	39.83±1.39	39.27±1.39	39.14±1.39	0.3663
3.5% FCM yield (kg/d)*	36.20±1.54[c]	32.97±1.54[b]	31.32±1.54[a]	<0.0001
ECM yield (kg/d)†	40.95±1.70[c]	38.12±1.70[b]	36.72±1.70[a]	<0.0001
Fat (%)	3.45±0.10[b]	2.94±0.10[a]	2.68±0.10[a]	<0.0001
Fat yield (kg/d)	1.35±0.07[c]	1.15±0.07[b]	1.04±0.07[a]	<0.0001
Protein (%)	3.58±0.02[a]	3.62±0.02[ab]	3.65±0.02[b]	0.0409
Protein yield (kg/d)	1.45±0.06	1.44±0.06	1.45±0.06	0.9444
Lactose (%)	5.07±0.03[a]	5.15±0.03[b]	5.17±0.03[b]	0.0067
Lactose yield (kg/d)	2.03±0.08	2.03±0.08	2.04±0.08	0.9271
Protein efficiency (%)‡	35.42±0.09[b]	36.21±0.09[b]	32.76±0.09[a]	<0.0001
3.5% FCM/DMI	1.47±0.05[b]	1.42±0.05[ab]	1.20±0.05[a]	<0.0001
ECM/DMI	1.66±0.06[b]	1.64±0.06[b]	1.41±0.06[a]	<0.0001
kg ECM per NEL§ intake (Mcal)	1.02±0.04[b]	1.03±0.04[b]	0.89±0.04[a]	<0.0001
Energetic efficiency (%)¶	0.65±0.01[b]	0.66±0.02[b]	0.56±0.02[a]	<0.0001

[a, b, c] Items within a row with differing superscripts differ ($P < 0.05$).

*3.5% Fat corrected milk yield = [0.4 × Milk yield (kg/d)] + [15 × milkfat yield (kg/d)].

†Energy corrected milk = [0.327 × milk yield (kg/day)] + [12.95 × milkfat yield (kg/d)] + [7.2 × protein yield (kg/d)].

‡Protein efficiency = [crude protein in milk (kg/day)]/[crude protein intake (kg/day)].

§Net energy for lactation (NEL) calculation performed by using the summative equation described in NRC Nutritional Requirements of Dairy Cattle (2001).

¶Energetic efficiency = [estimated gross energy in milk (mcal)]/[NEL caloric intake (Mcal)], estimated gross energy of milk (Mcal) = [4 × milk protein (kg/day)] + [4 × milk lactose (kg/day)] + [9 × milk fat (kg/day)].